

# Needle Control Valves Models 8503 and 8504

Variable Area



Model 8504  
Straight Pattern  
CART III Needle Valve

Model 8503  
Angle 90° Pattern  
CART III Needle Valve

## Low Flow Gas and Liquid Flow Control Valves

### Description

Model 8503 (angle, or 90° pattern) and Model 8504 (straight, or “in-line” pattern) needle control valves incorporate either the Brooks Cartridge III series of standard resolution, or the Brooks NRS™ series of precision resolution control valves. Both of these Brooks valve series are combined with cast 316 stainless steel bodies to provide a full range of control for low flow gas and liquid applications.

The Brooks Cartridge III (“CART III”) valve is a multi-purpose valve, designed for integral use in the Brooks Sho-Rate™ 1350G/1355G series of “Purgemeters”, as well as for use as a stand-alone needle valve, when incorporated in the 8503/8504 bodies. These valves are available in three different sizes - Low, Medium and High. The needle valve stem of this design features a conical taper, which, when combined with various ceramic orifices, ensures a wide range of flow capacities for common gas and liquid purge-type applications.

The Brooks NRS™ (non-rising stem) valve is designed specifically for extremely low flow gas and liquid applications. These valves feature a unique means of precisely adjusting an orifice along a tapered needle, and are particularly suited for critical flow control requirements. Due to its non-rising stem design, this valve is significantly less susceptible to changes in ambient temperature and mechanical effects than a conventional needle control valve.

### Features

#### CART III

- Large, easy to set knob
- Rugged design, with stable flow adjustment and repeatability
- Eight turns open-to-close
- Wide flow rangeability provided by three, overlapping valve sizes

#### NRS™

- Smooth, non-reversing flow characteristics
- Constant flow at any given knob position
- Excellent resolution with fifteen turns open-to-close
- Seven needle tapers (Sizes 1-7) provide overlapping ranges, each size increasing maximum capacity by approximately three times
- O-ring seal design provides tight shut-off, and incorporates a mechanical stop to eliminate overtightening damage
- Panel mounting nuts are standard

#### Common

- 1/8” FNPT integral connections or 1/4” FNPT connections via included adapters

## Product Specifications

|  |  |
|--|--|
| Capacities and Pressure Drops                          | See Capacity Table   |
| Max. Operating Pressure                                | 1000 psig  |
| Max. Operating Temperature                             | 250°F  |
| Connections  | Standard: 1/8" Female NPT - integral<br>1/4" female NPT  |
| Dimensions   | See Dimensions Figure  |
| <b>Materials of Construction Stainless Steel Model</b> |  |
| Body & Stem  | 316 stainless steel  |
| Orifice  | NRS Size 1-3: Stainless steel and Teflon®; NRS Sizes 4-6: Stainless Steel; CART III all sizes: PEEK® (ceramic) |
| Valve Needle   | 316 stainless steel  |
| Plunger (NRS only)                                     | Stainless steel  |
| O-rings  | Viton® fluoroelastomers; Buna-N  |

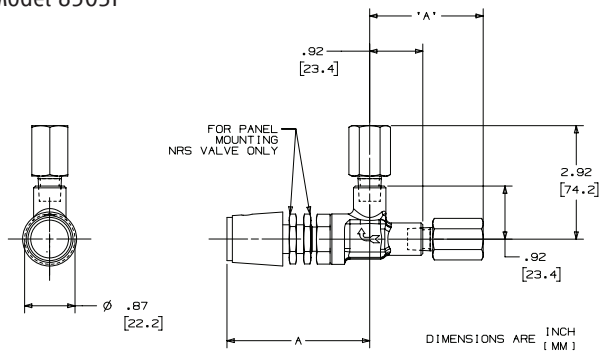
### Capacity Table

| NRS           |       |            |       |          |       |       |        |         |
|---------------|-------|------------|-------|----------|-------|-------|--------|---------|
| Needle Taper  | Air   | He         | Water | Cv       | Kv    |       |        |         |
| Units         | SLPM* | (N)M3/HR** | SLPM  | (N)M3/HR | LPM   | L/HR  |        |         |
| 1             | 0.15  | 0.01       | 0.3   | 0.02     | 0.004 | 0.292 | 0.0003 | 0.00031 |
| 2             | 0.35  | 0.02       | 0.7   | 0.04     | 0.01  | 0.73  | 0.0007 | 0.00073 |
| 3             | 0.6   | 0.04       | 1.4   | 0.08     | 0.02  | 1.46  | 0.0013 | 0.00126 |
| 4             | 2.4   | 0.14       | 6     | 0.36     | 0.08  | 5.84  | 0.0057 | 0.00502 |
| 5             | 6.8   | 0.41       | 18    | 1.07     | 0.2   | 14.6  | 0.017  | 0.01423 |
| 6             | 22    | 1.31       | 55    | 3.28     | 0.65  | 47.45 | 0.052  | 0.04602 |
| 7             | 43.8  | 2.61       | 109.5 | 6.53     | 1.35  | 98.55 | 0.112  | 0.09163 |
| CART III Size |       |            |       |          |       |       |        |         |
| Low           | 5.7   | 0.34       | 14.9  | 0.89     | 0.176 | 13    | 0.015  | 0.012   |
| Medium        | 19.7  | 1.17       | 50    | 2.98     | 0.712 | 51    | 0.05   | 0.044   |
| High          | 75.6  | 4.51       | 94    | 5.60     | 2.04  | 147   | 0.193  | 0.167   |

\*U.S. Customary Units capacities measured with 10 PSIG supply and atmospheric exhaust. Standard Temperature is 70°F and Standard Pressure is 14.7 PSIA.  
 \*\*Standard International (SI) Units measured with 1 BarG supply and atmospheric exhaust. Normal Temperature is 21.1°C and Normal Pressure is 1.013 Bar.  
 Flow capacities will vary for different gases, liquids and valve pressure drop (ΔP).

## Product Dimensions

### Model 8503F

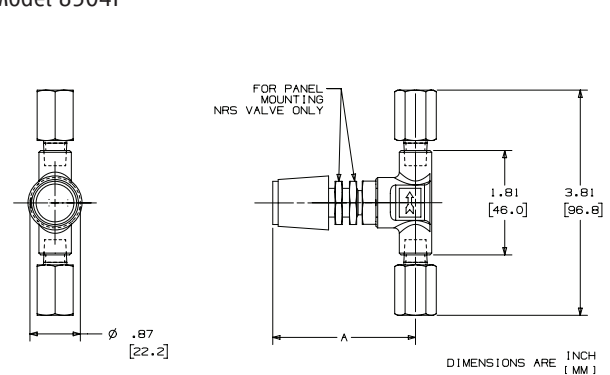


#### NOTES:

1. VALVE BODY IS 1/8"NPT INTEGRAL CONNECTION, NO ADAPTER NEEDED.

| A (OPEN)            |             |
|---------------------|-------------|
| NRS VALVE           | 2.50 [63.5] |
| CARTRIDGE III VALVE | 2.65 [67.3] |

### Model 8504F



#### NOTES:

1. VALVE BODY IS 1/8"NPT INTEGRAL CONNECTION, NO ADAPTER NEEDED.

| A (OPEN)            |             |
|---------------------|-------------|
| NRS VALVE           | 2.50 [63.5] |
| CARTRIDGE III VALVE | 2.65 [67.3] |

## Cartidge Valve Sizing

### GAS - United States Customary Units

The correct cartridge valve can be determined for any gas by using one of the formulas below:

1. Subcritical Flow Formula (when downstream pressure,  $P_2$ , is greater than the critical pressure  $P_c$ , or  $P_1 < 2P_2$ )

$$C_v = \frac{Q}{454} \sqrt{\frac{(SG) \times (T)}{P_1^2 - P_2^2}}$$

2. Critical Flow Formula (when downstream pressure,  $P_2$ , is less than the critical pressure  $P_c$ , or  $P_1 > 2P_2$ )

$$C_v = \frac{Q \sqrt{(SG) \times (T)}}{385 \times P_1}$$

Note: Critical pressure is equal to approximately 1/2 of the upstream absolute pressure. ( $P_c = 1/2 P_1$ )

Where:

- $C_v$  = Valve flow coefficient
- $Q$  = Gas flow in slpm
- $SG$  = Gas specific gravity (See Specific Gravity Table)
- $T$  = Absolute temp. of flowing gas in °R (°F + 460)
- $P_1$  = Upstream pressure (psia)
- $P_2$  = Downstream pressure (psia)
- $P_c$  = Critical pressure (psia)

### LIQUID - United States Customary Units

The correct needle valve can be determined for any liquid by using the formula below:

$$C_v = 0.264 (Q) \sqrt{\frac{(SG)}{\Delta P}}$$

Where:

- $C_v$  = Valve flow coefficient
- $Q$  = Liquid flow (slpm)
- $\Delta P$  = Pressure drop (psi)
- $SG$  = Liquid specific gravity

### Specific Gravity and Density Table for Gases

| Gas            | Specific Gravity Referred to Air at 70°F (SG) | Density (kg/m <sup>3</sup> ) |
|----------------|---|------------------------------|
| Acetylene      | 0.907   | 1.173                        |
| Air            | 1.0   | 1.293                        |
| Ammonia        | 0.587   | 0.771                        |
| Argon          | 1.38  | 1.784                        |
| Butane         | 2.07  | 2.593                        |
| Carbon Dioxide | 1.529   | 1.977                        |
| Helium         | 0.138   | 0.178                        |
| Hydrogen       | 0.0695  | 0.090                        |
| Methane        | 0.554   | 0.717                        |
| Nitrogen       | 0.967   | 1.251                        |
| Oxygen         | 1.105   | 1.429                        |
| Propane        | 1.562   | 2.008                        |
| Sulfur Dioxide | 2.264   | 2.858                        |

### GAS - Standard International Units

The correct cartridge valve can be determined for any gas by using one of the formulas below:

1. Subcritical Flow Formula (when downstream pressure,  $P_2$ , is greater than the critical pressure  $P_c$ , or  $P_1 < 2P_2$ )

$$K_v = \frac{Q_{max}}{514} \sqrt{\frac{\text{density}(T)}{\Delta P (P_2)}}$$

2. Critical Flow Formula (when downstream pressure,  $P_2$ , is less than the critical pressure  $P_c$ , or  $P_1 > 2P_2$ )

$$K_v = \frac{Q_{max}}{257(P_1)} \sqrt{\text{density}(T)}$$

Where:

- $K_v$  = Valve flow coefficient
- $Q_{max}$  = Gas flow (m<sup>3</sup>/h)
- Density = Gas density (kg/m<sup>3</sup>) (See Specific Gravity Table)
- $T$  = Absolute actual operating temp. °K (°C + 273)
- $P_1$  = Upstream pressure (bar abs)
- $P_2$  = Downstream pressure (bar abs)
- $\Delta P$  = Pressure drop (bar)

### LIQUID - Standard International Units

The correct cartridge valve can be determined for any liquid by using the formula below:

$$K_v = (Q_{max}) \sqrt{\frac{(\text{density})}{\Delta P(1000)}}$$

Where:

- $K_v$  = Valve flow coefficient
- $Q_{max}$  = Liquid flow (m<sup>3</sup>/h)
- $D$  = Fluid density (kg/m<sup>3</sup>)
- $\Delta P$  = Pressure drop (bar)

## Model Code

| Code Description                         | Code Option | Option Description           |
|--|-------------|------------------------------|
| I. Base Model Number                     | 8503F       | Angle pattern                |
|  | 8504F       | In-line pattern              |
| II. Material of Construction             | 2           | 316 Stainless Steel          |
| III. Needle and Orifice Size             | A           | NRS Size 1                   |
|  | B           | NRS Size 2                   |
|  | C           | NRS Size 3                   |
|  | D           | NRS Size 4                   |
|  | E           | NRS Size 5                   |
|  | F           | NRS Size 6                   |
|  | G           | NRS Size 7                   |
|  | 1           | CART III Low                 |
|  | 2           | CART III Medium              |
|  | 3           | CART III High                |
| IV. O-ring Material                      | A           | Buna N                       |
|  | B           | Viton® fluoroelastomers      |
| V. Inlet/Outlet Connections, Size & Type | 1A          | 1/8" NPT (integral)          |
|  | 3C          | 1/4" NPT (adapters supplied) |

### Sample Standard Model Code

| I     | II | III | IV | V  |
|-------|----|-----|----|----|
| 8504F | 2  | 1   | B  | 1A |

## Service and Support

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit [www.BrooksInstrument.com](http://www.BrooksInstrument.com) to locate the service location nearest to you.

### START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required. For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

### SEMINARS AND TRAINING

Brooks Instrument can provide seminars and dedicated training to engineers, end users, and maintenance persons.

*Please contact your nearest sales representative for more details.*

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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